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Technological innovation policies to promote renewable energies: Lessons from the European experience for the Brazilian case

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Abstract

Over the past few years we have been seeing a trend in the Brazilian political scenario towards increasing the share of new renewable energy sources (RES-E), other than large hydropowers, in electricity generation. The central policy was achieved through PROINFA (Program to Encourage Alternative Energy Sources), which defined two distinct stages and mechanisms to promote biomass, SHPs and wind energy. This study aims to analyze the developments in renewable energy policies and the prospects for Brazil based on the European experience in promoting RES-E. It evaluated the policy instruments adopted by the United Kingdom, the Netherlands and Germany, as well as the barriers and results of these policies. Based on these case studies, proposals and recommendation are given to overcome the problems in the Brazilian case.

Keywords: Renewable energy sources; Energy policy; Wind energy; Biomass; Brazil; PROINFA

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Contents

1. Introduction

1.1. Background and problem

Brazil is a country that produces clean energy due to the large share of hydropower in its energy supply mix. Nevertheless, the use of new renewable energy source (RES-E) in the electricity sector such as small hydropower (SHP), wind, and biomass is small, when we consider the huge existing potential. Among the reasons for this situation are: the large Brazilian hydropower potential—today only 24% of this potential has been harnessed and the relatively low cost of implementing and generating large-scale hydropower facilities. Furthermore, the high associated costs and the intermittence of RES-E do not make these sources very attractive.

In spite of some initiatives in Northeastern Brazil for installing wind energy systems connected to the transmission grid, RES-E have had their use restricted to research, development and demonstration of pilot projects for electrification of rural and isolated communities, where the long distances made expanding the electricity grid unfeasible.

Recently, Brazil has enacted a Law n^{o}. 10,438, creating the PROINFA (Program to Encourage Alternative Sources of Energy),[1] setting targets to increase the share of electricity produced from RES-E in the interconnected system. Launched in the previous government, PROINFA has faced some difficulties related to the nature of the policy and incentives adopted.

In this regard, this study attempts to highlighted the possible steps to put forward an effective policy for RES-E in Brazil, based on the European experience.

1.2. Background of the European context

In Europe, policies for promoting renewable energies were based on the "White Paper for a Community Strategy and Action Plan, 1997". In this document, the European Commission (EC) proposed a target to double the share of renewable energy, from 6% to 12%, in the production of primary energy by 2010. This corresponded to 22% of the consumption of electricity generated by RES-E. Following up on this policy, the EC launched, in 2001, the directive "Promoting Electricity from Renewable Energy Sources in the International Electricity Market (2001/77/EG)". This directive established targets for each member state for renewable-based electricity consumption and determined that from 2003 onwards, each member state should establish a certification system to demonstrate the origin of the entire production of renewable energy. This certificate did not need to be "*tradable*", but, in order to ensure that in the future it could be exchanged within the European Community, the directive established that this system should be mutually recognized by EU member states.

The main instruments used to promote RES-E in Europe are: Tender System, Feed-in Tariffs, and Quota Obligation Systems (with green certificates). These instruments usually co-exist with other instruments such as fiscal incentives, support for research and development and charges.

No consensus has been reached so far concerning which instrument would be better to promote renewable energies in Europe. According to Busch [1], the European directive tends to favor the system of quotas with green certificates to ensure a trading system in the future. Nevertheless, European countries that have adopted feed-in tariffs had a considerable increase in the share of RES-E in electricity production. In addition, the recently assessment of the various instruments published by the EC [2] indicated that feed-in tariffs are currently cheaper and more effective than the quota systems, particularly in the case of wind energy. It also stated that one of the reasons that the quota system is more expensive is the high risk to the investor because of the immature market. The EC also indicated that a harmonization proposal of the various instruments for promoting renewable energy sources within the EU at this stage is unlikely and competing national schemes can be healthy, at least in a transitional period, as more experience needs to be acquired.

Far from being over, this discussion has given rise to much controversy in academic and political spheres. In the available literature [1–6,11–16,20] several studies are underway to

[1]PROINFA is divided into two phases: PROINFA 1—with the goal of adding 3300 MW by the end of 2006, equally divided into wind, SHP and biomass; and PROINFA 2–10% of wind energy, biomass and SHP in electricity consumption by 2022.

analyze and assess these instruments, as well as to identify the reason for choosing one instrument over another.

Based on these studies, below is a review of the models adopted by the United Kingdom, the Netherlands and Germany. Later, the Brazilian situation will be discussed. This article does not intend to discuss which is the best policy instrument to be adopted by Europe, but, rather, its aim is to identify perspectives and provide guidelines for promoting RES-E in Brazil.

2. Case studies: an overview of UK, Holland and Germany experience in promoting RES-E

2.1. United Kingdom

2.1.1. Political context

The United Kingdom has a centralized system of government, which provides the government with a great deal of capacity to control policy reform [3]. As a result, there is little participation at local and regional levels of government, which in their turn, have little political and financial capacity[2] [4]. The renewable energy industry does not have much political representation[3] and traditional environmental organizations in England exert their role to promote renewable energies.

In 1989, the government liberalized the electricity market and competitiveness was introduced in energy generation. Due to the difficulty in privatizing nuclear generation and also to ensure competition, the government decided to exclude nuclear energy from the privatization process and established subsidies, creating a support mechanism called NFFO—Non Fossil Fuel Obligation [5].

2.1.2. Renewable energies and adopted policy instruments

The first initiatives for introducing renewable energy started in 1988, when the British Government presented plans for the development and exploitation of renewable energy sources. These early plans were to be attained by extending the scope of an already existing policy to the area of renewable energies, i.e. The Non Fossil Fuel Obligation—NFFO for Nuclear Power Generation [3].

The NFFO was established in 1990. This system was initially created to ensure the purchase of electricity generated from nuclear and renewable sources. This system was financed by the "Fossil Fuel Levy (FFL)" and paid by the end consumer. Nevertheless, a small amount of the budget was intended to support renewable energy generation. Until 1996, more than 90% of the budget was used to subsidize nuclear energy (Nuclear Obligation). In 1996, the EC threatened not to approve the FFL, because in European law, such a substantial subsidy would only be justified in certain cases, such as, for environmental reasons. As a result, in 1998, 49% of the FFL budget was applied to renewable energies[4] [3].

One of the responsibilities of the Department of Trade and Industry (DTI), which was the agency responsible for regulating the energy industry, was to define the amount of

[2]The Blair administration has been steadily introducing greater participation at local and regional levels.

[3]Over the last few years, the wind energy industry has been increasing its participation in political decisions.

[4]During this period, there was an enormous reduction of the total FFL budget, in spite of the increase of the share of renewable energy sources.

renewable energy that would be eligible to receive the FFL subsidy. This definition was based on the principle of "quota regulation", which implied the involvement of government in the definition and implementation of renewable energy projects. "Hence, the UK renewable energy policy was initiated with a top-down approach by the public administration. The strong role of the central government is not only indicated by its power to define the eligible capacity of renewable energy generation but, also, to determine the capacities of different renewable energy technologies (so-called technology bands)" [3].

The policy instrument used to promote RES-E was a Tender System, whereby generators, using eligible types of RES-E, competed for limited capacity within specified technological bands. The cheapest bids within a single technology band were given the contracts and were eligible for support. Altogether there were five tendering processes, resulting in reduced prices, "which may be partly due to the fact that the best wind sites were involved" [6].

Nevertheless, in later rounds of the NFFO there was a difference between the contracted and commissioned projects: 79% of the projects contracted in NFFO 1 were commissioned, as opposed to only 33% in NFFO 5. According to Suck [3], this can be attributed to the excessive emphasis on competition and also to the centralized nature of the planning system in the UK[5] which restricts implementation of decentralized renewable energy projects. Another more serious reason would be the fact that renewable energies generators set their supply prices lower than their generation costs, which may be explained by the fact that the contract was applied to future projects that were to start operations in 5 years. Thus, the expectation of further technological development and an ensuing drop in the cost of RES-E allowed renewable energy generators to calculate the production costs in a decreasing basis.

In 1997, with the change in government,[6] legislation was revised and the adopted policy favored a greater social and environmental dimension in the government [4]. In addition, external reasons related to the adoption of the Kyoto Protocol and the negotiations to reduce greenhouse gases emissions provided the necessary conditions for restructuring renewable energy policies in the UK. Thus, in 2000 "The Utilities Act" came into force, establishing a new regulatory framework for the gas and electricity markets. The most important part of this reform was the creation of the New Electricity Trading Arrangements (NETA), which began operations in March 2001[7] and the Renewables Obligation (RO), which only began operations in April 2002 [7a].

The new Renewables Obligation required power suppliers to derive from renewables a specified proportion of the electricity they supply to their customers. This started at 3% in 2003, rising gradually to 10% by 2010. The cost to consumers is limited by a price cap and the obligation is guaranteed in law until 2027. Eligible renewable generators receive Renewables Obligation Certificates (ROCs) for each MWh of electricity generated. These certificates can then be sold to suppliers, in order to fulfill their obligations.

[5]Local and regional planners usually give greater emphasis to local environmental factors than to national renewable energy targets. Thus, the lack of planning capacity at the regional and local levels and the absence of awareness of the generation of sustainable energy reinforced the existence of campaigns against renewable energy projects (particularly against wind energy) [3].

[6]Labor Party.

[7]NETA was created to improve the conditions of market competition in the United Kingdom and to promote reduction of electricity prices, because the liberalization model launched in 1989 failed to lead to competition in the wholesale market.

Suppliers can either present enough certificates to cover the required percentage of their output, or they can pay a 'buyout' price of €47.03/MWh[8] for any shortfall. All proceeds from buyout payments are recycled to suppliers in proportion to the number of ROCs they present. ROCs can be freely traded and the price varies according to the ratio of ROCs to buyouts (which increase the overall value of the ROCs). ROCs have traded as high as €68.37/MWh, but there is no guarantee that they will remain at this price. ROCs have increased the profitability of renewable energy generation as the certificates can currently be sold for more than the power. This is especially true for wind, which was already producing electricity at competitive prices. OFGEM–The Office for Gas and Electricity Markets is the agency responsible for implementing and monitoring ROs.

The Utilities Act also created the "Climate Change Levy—CCL". This is a new tax on energy use for both business and public sectors. The principal aim of the levy is to encourage non-domestic electricity users to become more energy efficient and so reduce carbon emissions. In 2001 the CCL was €62.55/MWh (0.43 p/kWh). Renewable energy generators can request tax exemption since the energy from renewable sources does not contribute to global warming. This works more as an incentive for energy suppliers and major consumers to use RES-E. Self production of electricity of RES-E is also tax exempted.

In 2003, the British Wind Energy Association (BWEA) [8] stated that the British Government should clarify its policy in the long-term or it engenders the risk of a financial crisis in the sector. The Association said it is extremely difficult to obtain financing for the sector and requested a policy review to ensure the security of investments in the long term. As a response, the government increased the share of renewable energies to 15% in 2015 (in April 2005) and intends to review the policy in 2006.

A recent study—Financing Wind Beyond 2010—Possible Solutions [9] commissioned by BWEA shows that the review: must work within the constraints of the overall regulatory process, particularly at a EU level; should provide a long term incentive to build renewables; should reduce regulatory uncertainty and promote confidence in the industry.

2.1.3. Results

The NFFO supported circa 85% of all the production of renewable energy in the UK [6], nevertheless, the share of RES-E in electricity generation has only reached 2.7% in 2000, in comparison to 1.9% in 1990. In 2003, the share of RES-E in generation reached 2.8% [10] corresponding to 11.161 GWh—below the 3% target established in the RO for the same year. Of this amount, 1.285 GWh came from wind energy.

As seen in Table 1 below, RO provided a new impulse to wind energy. Since solar energy is a more expensive technology, it was not considered for promotion under the NFFO and RO. Application of this technology has been done through specific British government programs.

Fig. 1, below, shows the increase of electricity generation by ROC-eligible plants in the UK since 1999. The annual growth rate has significantly increased since the introduction of the obligation. However, the obligation has not yet been able to stimulate many new large-scale developments. This is due both to the short time of implementation of the RO in 2002, and the difficulties of the obligation for developers. Despite the level of the

[8]This rate will be applied for the period 1 April 2005–31 March 2006.

Table 1
Installed capacity (MW) in the UK by NFFO and by the Renewable Obligation (RO)

	NFFO[a]	RO[b]	NFFO + RO[c]
Wind energy	245.5	444.5	690
Small hydropower	49.3	—	—
Biomass	106.5	52	158
Landfill	510	83	592.8
Sewage gas	25	30	55.3

[a]Live projects, October 2005.
[b]Developed by authors, based on Eurostat, DTI and OFGEM data, 2004.
[c]Total installed generating capacity of accredited generating stations—2004. NFFO generating stations made up 7.7% of the accredited RO capacity in 2003/2004 [7b].

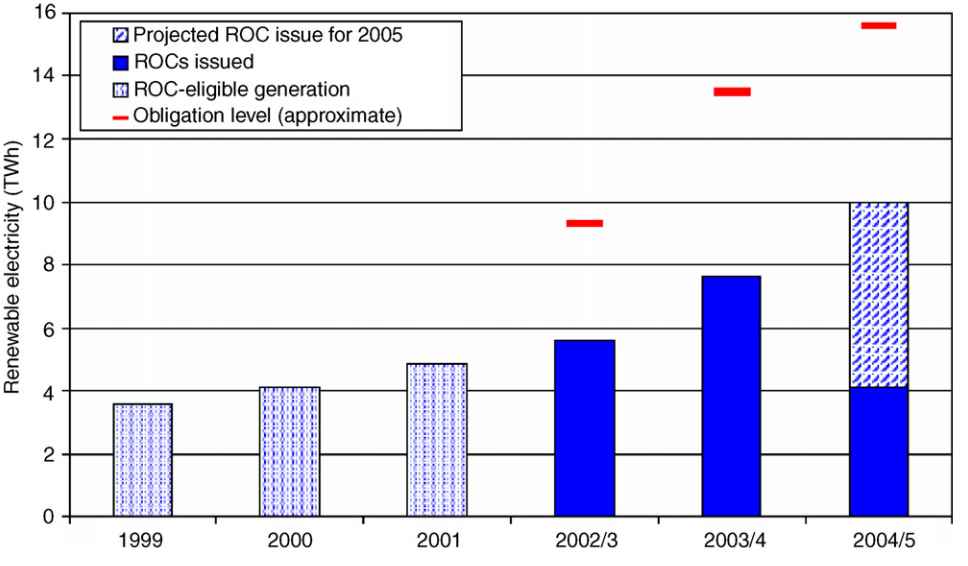


Fig. 1. Renewable electricity generated in the UK on a ROC-eligible basis [10].

obligation growing rapidly, it is far higher than the generation from renewables achieved to date [11].

2.1.4. Barriers to the promotion of renewable energies

Analyzing the policy for promoting RES-E in the UK, the main barriers found are closely linked to the principles of market liberalization. "Renewable energies were not seen as particularly practicable nor feasible during the market transition period and policy makers did not realize they could be a realistic alternative" [3]. The idea was to ensure competitiveness, reduce the price of electricity and not overburden the electricity utilities. From this perspective, the creation of a new renewable energy industry was mainly for exporting.

The centralized planning system, which did not favor local and regional participation in renewable energies policies, contributed to the unwillingness of the population in accepting the projects, particularly the wind energy ones. So much so that today wind energy projects are being directed to offshore construction.

Concerning the adopted instrument, the tender system had problems related to the competitive nature of the instrument, which did not reflect the real costs of generation, since the RES-E generators set the price at below market levels. One way of solving this problem would be to create mechanisms that ensured the true price of the technology.

The Renewable Obligation is a new instrument, which has not allowed its analysis up to now. It is still not possible to say how far it is supporting RES-E, although generation has recently increased. An evaluation of the performance of the obligation scheme by ECN [11] states that, "from the perspective of the renewable generators, the RO is now considered to be generally effective. However, whilst larger companies have been able to use their balance sheets in order to invest in new renewable capacity, smaller developers have found it more difficult to raise financing from the banking sector. With respect to market efficiency, given the limitations of the ROC market in terms of the number of required parties, liquidity, and difficulties in long-term contracting, market efficiency has also been limited. Taking cost effectiveness into consideration, the cost to the end consumer, so far, has been relatively low, currently at around €2.18/MWh (0.15 p/kWh), compared to their final prices (about €109/MWh (7.5 p/kWh) for standard daytime electricity, exclusive of VAT). However, the RO is based on the assumption that all renewable technologies can compete, which is not the case in the UK. In particular, the system does not sufficiently support merging and still non-competitive technologies, such as offshore technologies and biomass, and so other support mechanisms have been introduced to support some of these".

2.2. The Netherlands

2.2.1. Political context

The Netherlands have a centralized political system. The country is divided into 12 provinces that have little parliamentary and financial mandate to actively participate in decision making. The energy intensive industries have a major influence in government and do not wish to increase financial costs and the various social actors exert little influence [4]. Furthermore, there are major natural gas reserves in the Netherlands and this sector has a strong role within the electricity generation sector [12].

As a result of the international policy on climate change and the role of renewable energies to reduce greenhouse gases, the discussion of promoting this source of energy has been increasing and the Dutch government published its White Paper on Energy, setting the long-term goal for renewables at 10% of the total energy supply in the Netherlands in 2020. The main emphasis was put on renewable electricity, where, recently, the Dutch government stipulated a target of 9% for 2010.

In this scenario, and in the context of market liberalization (which occurred in the Netherlands from 1998 to 2000), policies for promoting renewable energies were developed on voluntary initiatives, cost efficiency and promotion of demand [12].

2.2.2. Renewable energies and adopted policy instruments

The policy for promoting RES-E in the Netherlands was developed in a complex manner. The various phase-ins and -outs of the support instruments and the confusing political context leads to uncertainties in markets, making the implementation of renewable energy projects difficult, particularly wind energy.

Before 1996, RES-E were supported by a mix of instruments going from feed-in tariff based on avoided cost,[9] direct subsidies, investments support, and tax exemption. In addition, a voluntary agreement among the energy distributing companies and the government established the Environmental Action Plan (MAP), in 1991, where a tax on consumption was charged—the MAP Levy. The MAP Plan provided for a series of measures for energy savings and conservation, and for the introduction of renewable energy sources[10] [5].

In 1996, the government introduced a regulatory energy tax (Regulerende Energie Belasting, REB or Ecotax), which is a tax applied to the consumption of electricity, natural gas and heat oil—for small and medium-scale energy users. A share of this tax was paid back to renewable energy generators as a production subsidy. The RES-E included were wind, solar energy, hydropower with capacity of less than 15 MW, biomass and biogas. Imported electricity from these sources were also eligible to receive this subsidy.

In 1998, the government introduced the "Nil Tariff", which consists of tax exemption for all domestic generators of renewable energies and for sale of imported energy. In addition, all the consumers of RES-E electricity were also exempt from this tax and from the MAP Levy. "Consequently, this instrument became powerful for stimulating demand for renewable energies" [5].

Furthermore, gradual opening of electricity market allowed consumers to have a free choice of RES-E suppliers: Since January 1999, all major electricity consumers (those that consume more than 10G Wh a year) could freely choose their energy provider: A year later the market was opened to the mid-scale consumer; Since July 2001, all consumers can choose their energy supplier. Thus, the energy policy with energy market liberalization was implemented as a way to avoid the high costs of electricity companies, transferring to the consumer the responsibility for the increase in renewable energy [4,12].

Revision of the Environmental Action Plan (MAP) in 1997 (called MAP 2000) established a voluntary target of 1700 GWh from RES-E to be adopted by distribution companies and supplied to consumers by 2000. To prove the achievement of this target, the distribution companies introduced a Green Label Trade system.[11] The aim was to establish a basis of a green electricity market to operate later under the European certificate system. "It was believed that the experience acquired in the experimental market of green certificates could be useful when the market were really established in the EU" [4].

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[9]The feed-in tariff was gradually decreased until it ended as the market opened up to competition. It was operated under the SAR (Standard Arrangements for Re-deliveries) until the end of 2000.

[10]The Environmental Action Plan (MAP) was voluntarily adopted in 1991 by the distribution companies for the reduction of CO_2 emissions in the energy industry. The MAP Levy was a charge between 0.5% and 2.5% of consumer's tariffs to be used in energy efficiency and on renewable energy sources as an investment or subsidy for production. This MAP Plan was revised in 1994 and 1997 (MAP 2000).

[11]The experimental certificates system did not include payments made during 1998 and 1999, due to the experimental stage of the market. Payments among distributors were postponed for when the market was *de facto* established (ECN-ENW-99).

Thus, any domestic generator of green electricity eligible for ecotax exemption and for production subsidy (REB funds) had the right to receive the Green Label for every 10,000 kWh produced. Since the imported green electricity was also eligible for tax exemption and production subsidy, it could also receive the Green Label "as the certificates were attached to the REB benefits" [13]. In 1998 and 1999, the amounts of imported green electricity were small but with the approaching 2000 deadline and the large gaps to targets for some companies, imports of green electricity increased during 2000 [4]. However, a joint decision of distribution companies has ultimately established that the Green Labels issued for imported green electricity should be neither be tradable nor to count towards the company's MAP targets of those who imported them [14].

Thus, in 2000, only three provider companies had fully achieved their respective voluntary targets and the others were not able to certify for the Green Label, or only partially [4]. Data published by EnergieNed show that, in 2000, companies were able to achieve 1500 GWh [5]. The reasons for not meeting the targets are mainly due to the difficulties inherent to the building of new capacity from renewable energy sources, mainly wind energy projects.

The argument of not establishing any obligations for government or industry to promote renewable energy and the possibility of international application of green certificates led to the legal establishment, in 2001, of the voluntary green certificate market [4].

Green certificates could be any size, but always multiples of 1 MWh and were valid for a year. The institution authorized to coordinate the market is TenneT—considered to be an independent generating body and green electricity market. Initially only RES-E generators situated in the Netherlands using wind, photovoltaic solar energies or hydropower less than 15 MW and pure biomass could request certification. Notwithstanding, in October 2001, a decision of the Ministry of Economic Affairs, made it clear that only green certificates without the physical importing of electricity are not eligible for market and for tax exemption (REB). This fact is seen as a commitment to the "greening" of the energy supply and to the EU targets [15].

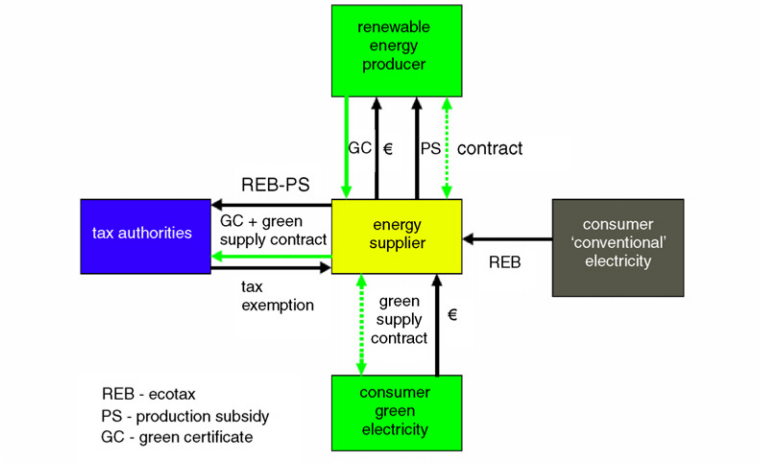
In this context, the ecotax (REB exemption)[12] was the main instrument in the Netherlands, because it was through this instrument that consumers was able to choose the source of renewable energy without paying extra for this energy. As an example, the number of clients consuming green electricity went from 250,000 in July 2001 to approximately 2.2 million (32% of households) by October 2003 [16].

The relations of ecotax to the green certificate system was as follows in Fig. 2:

The tax in 2002 corresponded to €60/MWh (6.01 €ct/kWh). Out of this income, €2.00 ct/kWh were passed on to the renewable energy generator as production support. In this way, renewable energy was supported with €8 ct/kWh. This allowed energy suppliers to provide green electricity (particularly from biomass) for the same price as conventional energy [15].

Nevertheless, in 2002 the Ministry of Economic Affairs identified, in its "Energy Report" [17], the adverse effects of this policy instrument: There was a flow of ecotax to the foreign market, but this did not reflect additional investments in the capacity in renewable energy in the countries of origin; and also, the ecotax, domestically, was not capable of ensuring security for investors, who still had to compete with the low costs of imported energy. Thus, in 2003, a proposal to amend the 1988 Electricity Law was made,

[12]Since January 2002 hydropower is not eligible for the ecotax exemption.



- Electricity suppliers collect the ecotax from the consumers of conventional electricity.
- Consumers of green electricity pay suppliers a premium price for the green electricity but do not pay the ecotax.
- Energy suppliers buy the green electricity from renewable energy generators and/or green certificates, which is used to prove how much green electricity is supplied to their clients.
- In addition, the electricity suppliers provide a production subsidy to the generators of renewable energies coming from the collected ecotax.
- Electricity suppliers transfer the income from the ecotax (REB) less the production subsidy (PS) to the competent authority.

In order to prove ecotax exemption, suppliers still have to submit to the competent authority the contracts for the supply of green electricity to their consumers and also the green certificates to attest the amount of existing green electricity.

Fig. 2. Relation between the Dutch green certificate system and the Ecotax [15].

called "Environmental Quality of Power Production (MEP)", which introduced a feed-in tariff for domestic generators (MEP feed-in) to reduce the risk of investments and to improve the cost-effectiveness of RES-E. At the same time, a reduction in ecotax exemption was proposed of €6 ct/kWh to €2.9 ct/kWh, as well as the end of the production subsidy (in order to reduce imports of foreign electricity).

MEP feed-in can be requested by renewable energy generators for a period of up to 10 years and is only applicable to electricity produced within the Netherlands. The level of support is differentiated by technology. The highest level of support (68 €/MWh) is ensured to offshore wind energy, PV, small stand-alone biomass installations, hydro, wave and tidal energy. For onshore wind energy, support is 49 €/MWh for the year 2003. The subsidy is financed by a levy on all the connections to the electricity grid (34 Euro/connection in 2003; 40 Euro/connection in 2006). This tax, however, is compensated by an

equivalent reduction in the annual ecotax, so that it becomes financially neutral to the consumer.

Shortly after these changes, the council of ministers submitted a new proposal to phase-out the ecotax exemption by January 2005, which was accepted. The total support level will not change because the MEP feed-in will be increased. This implies that the Netherlands will switch to a classic system based on feed-in tariffs, exclusively supporting domestic production. It should be noted that there is the possibility to increase the level of ecotax exemption again in the future. It depends on the needs to realize the national targets through imports or not.

Table 2 below shows the main phases in policy development since 1990:

We can see that the Netherlands has built and re-shaped its policy for renewables several times. The strongest trends of the Dutch policy were covered here, but there are still other systems (which are not voluntary but have a regulatory nature) such as purchase guarantee for small generators (in the 1998 law) and the purchase obligations contained in the "Standard Arrangements for Re-deliveries (SAR)" contained in the 1989 Law (See [5]).

2.2.3. Results

In 1993 about 1.8% of all the electricity came from renewable energy sources [10]. In 2003, the share of domestic production of RES-E was approximately 3.3%, corresponding to 3.864 GWh [18]. When considering the imported electricity amount of 9.712 GWh [19], the share increases to 11.2%, as seen in Table 3 (and so, achieving the European targets).

Nevertheless, the data published in October 2005 [18] show that the decrease in ecotax was enough to reduce the amount of imported energy: in the 6 first months of 2005, imports of renewable energy fell to about 6%; Electricity generated by the incineration of waste in electricity plants increased from about 1% in 2004 to 3% in the first half of 2005, the main cause of the increase in renewable energy output. In the same period wind energy contributed 1.9% in comparison to 1.6% in 2003; and the output of renewable electricity accounted for 6.4% of total domestic electricity use. Statistical Office Netherlands (CBS)

Table 2
Policies phases in the Netherlands

	1990	1996	1997	2000	2001	2003/2004	2005 onwards
(1) Voluntary Agreements–Environmental Action Plan–MAP 1991	■	■	■	■			
(2) Promotion of Demand–Ecotax (REB) and REB exemption		■	■	■	■	■	?
(3) Voluntary Targets–MAP 2000 replacing (1)-Target 1.700 GWh–Green Label System				■	■		
(4) Voluntary Green Certificates					■	■	■
(5) Promotion of supply–MEP feed-in tariffs						■	■

Table 3
Generation of renewable energy in the Netherlands

	Wind	Solar	Landfill gas	Sewage gas	Biomass	Imports	Gross electricity consumption (GWh)
GWh (2003)	1.302	30	161	133	2.248	9.712	109.486
% (2003)			3.3			7.9	
% (first half 2005)[a]			6.4			6	57.000

Source: [10,18,19].
[a]First half 2005—4.7% higher than the same period in 2003.

[18] data show that the installed capacity of wind energy rose from 442 MW in 2000 to 884 MW in 2003—an increase of 50% in 3 years.

2.2.4. *Barriers*

There are several factors that hinder the promotion of renewable energies in the Netherlands. Firstly, and most importantly, is the complexity and diversity of instruments, which confuse the investor, who fears lack of security in the long term. Furthermore, the gas industry has a significant role in the economy and there does not seem to be any perspective for changes in that area.

The process for permission of new constructions, according to the Ministry of Economic Affairs, lasts from 2 to 7 months more than in other European countries. This is a problem for wind energy, since there is much local resistance. The population has a typical ''Not-in-my-backyard'' attitude, that is, they support renewable energies as long as the projects are not in their own communities [12].

Thus, like in the United Kingdom, the construction of a wind energy industry was aimed at exports and there was not enough will to surmount internal obstacles, resulting in the fact that building new capacity was restricted to the aforementioned problems with the population and permission process.

With respect to the adopted instruments, until 2002 the instruments did not differentiate their support by the type of technology. Therefore, and because of the lower generating cost, most of the consumed electricity comes from biomass. Imported technologies decreased the pressure for building new capacity and absence of participation of the municipalities in the national objectives for promoting renewable energies hindered permission processes. In addition, geographical obstacles are significant in the Netherlands, where most of the surface is level and densely populated.

There are also doubts with respect to whether the trade of green certificates will work on a voluntary basis. Up to now there is no sanction mechanism and no annual target has been established for the quota system [4].

According to Dinica [5], ''the Dutch government did not create the right enabling conditions to reduce the barriers that hinder the development of renewable electricity generation. The renewable energy market was too unstable and fragmented to attract long-term financial support, where risk and long-term profitability are less certain''.

The MAP feed-in seems to have significant results, as the 2005 data show a reduction in imported energy and an increase of domestic production (although the Dutch government has already demonstrated that it is desirable that a part of the electricity in the Netherlands

should be imported, to meet the 2010 target). Nevertheless, a significant increase of the share of biomass in electricity generation was seen in comparison to wind energy. This may show that the level of subsidies may not yet ensure profitability to investors in wind energy.

2.3. Germany

2.3.1. Political context

Unlike the United Kingdom and the Netherlands, politics in Germany are decentralized. Together with the federal government, local and state administrations have an important role in governance, and the three levels of government have the capacity to legislate in energy policies, whereby the federal level has priority [3].

Market liberalization only took place in 1998 and, thus, the policy to promote renewable energies was not really guided by efficiency and competitiveness criteria. There was an interest in promoting renewable energies in the domestic market and for political image, because of global warming and climate change issues, mainly led by the German Green Party. Furthermore, energy companies were decentralized and scattered throughout the various levels of government and the wind energy industry in certain German states had a strong lobby, facilitating the development of policies to promote renewable energies in these states [4].

2.3.2. Renewable energies and adopted policy instruments

Germany is one of the largest producers and consumers of coal for electricity generation within the European Union [20], with a large share of imports in its energy supply mix. Initially as a result of the oil crisis and with the aim of promoting supply security and later for environmental reasons, since the early 1980s there have been state-level renewable energy projects.

These small-scale projects initially aimed to test the technical feasibility of the renewable energy sources. Later on, with the concerns engendered by global warming, promoting RES-E became a way of achieving the emissions reductions established in the Climate Change Convention.

The success in implementing state level programs was crucial to establishing a renewable energy industry, particularly wind energy. Among the most important state projects is the REN Program, in the state of North Rhine Westphalia. This program supported circa 300 MW of wind energy and 11 MW of photovoltaic solar energy until 1998, and was an example for other German states. Basically, the decentralized programs were important to convince the Federal Government in 1988 to support measures to promote wind energy and thus begin a 100 MW in various German states [4].

However, one of the pivotal problems for renewable energy generators was the process of feeding electricity into German grids by independent generators. Until then, this process had been regulated by an informal agreement between the BDI—Bundesverband der Deutschen Industrie e.V.; VDEW—Verband der Elektrizitätswirtschaft; and VIK—Verband der Industriellen Energie und Kraftwirtschaft. According to this agreement, the grid operators had no legal obligation to ensure access to their grid. If this happened, it was done so voluntarily and the reimbursement was usually less than the avoided cost. This made the process of supplying energy to the grid a profitable one for the electricity companies. Even so, there were an increasing number of wind energy projects because of the subsidies provided by state programs. The lobbies from wind energy operators in the

northeastern states of Germany and from the hydropower generators in the southern states to establish an amount for reimbursement resulted in the Electricity Feed-in Act (Stromeinspeisungsgesetz) in 1990 [3].

The Feed-in Act guaranteed a minimum premium price for the electricity generated by RES-E. All renewable energies generated received a minimum price per kWh supplied to the grid, and, in addition, the companies that operated the distribution networks were mandated by law to connect them and to reduce their production of conventional eletricity. ''Hence, the Law did not place a cap on the amount of RES-E that was eligible to receive this tariff'' [3]. The result was a very large increase in wind energy in Germany.

Another factor that contributed to the success of this Law was the capacity of states in reforming the state building laws,[13] thus facilitating renewable energies projects. This fact influenced the federal level, who later reformed the federal building laws (in 1996), helping the construction of new renewable energy facilities at the national level. Based on this law, the local level should define, in its zoning plans, areas for the installation of renewable energy sources. This legislative force provided local governments with an instrument to help the local population accept these projects. With legislative strength divided among the three levels of government, the planning system provided enough flexibility and efficiency to incorporate the interest of renewable energies at the local, regional and federal levels [3,4].

The Feed-In Act guaranteed a remuneration of about 90% of the average price of conventional electricity sold to the consumer during the previous year for wind and solar energy and 80% for other renewable energy sources. Due to the resistance of electricity companies against the feed-in tariffs, who went to the European Court to question the constitutionality of the law, and also because of the reduction in the reimbursement of renewable energies,[14] the renewable energy industry demanded improvements in the law. Generators of other sources of renewable energies, which were not receiving an adequate reimbursement (as is the case of solar, biomass and geothermal) were also interested in reforming the law [4].

The first reform occurred in 1998 and the objective was only to fill in the gaps until the reform itself was agreed upon. In this reform, a clause was introduced: if more than 5% of the amount of electricity sold by a company within a year came from renewable sources, the costs of additional reimbursement, above 5%, would be covered by the next grid operator, (i.e. there was a transfer of the cost burden from the local operators to the regional operators, and from the regional operators to the transmission system operators). Nevertheless, the increase in wind energy was fairly accelerated: Only 1 year later, in 1999, one of the transmission system operators announced that his quota would be achieved in a few months. Since the increase in wind energy was mainly in the maritime regions of Germany, the companies in those states were burdened with the reimbursement costs and this only increased the resistance to the feed-in tariff [3].

[13]At the state level, emergence of lobbies for renewable energies, particularly wind energy, led to the fight for changes in the states' building laws. North Rhein Westphalia and Lower Saxony were the first states to define, in their planning programs, areas for generating renewable energies. The mandate of the states to define their energy policy in regional and spatial planning proved to be decisive [3].

[14]With liberalization of the energy market, the price of conventional energy decreased. Since the reimbursement paid to renewable energy generators was related to the price of conventional energy, the amount for RES-E reduced by the same percentage.

Thus, in April 2000, the Renewable Sources Act (Erneuerbare Energien Gesetz—EEG) was enacted. This law established an equalization system throughout the German territory as it promoted the distribution of the costs of the reimbursements among all the electricity companies. Electricity companies had to comply with a calculation system to balance out the costs of reimbursement among the various levels of grid operators. And it also brought special support for other renewable energy technologies. The basic principles are: Fixed payment for new installations; no compensation for inflation; and a long period for reimbursement.

The Renewable Sources Act does not imply a long-term subsidy for renewable energy technologies. In order to cut generating costs and increase the efficiency a decreasing price element for the technologies was introduced.

In 2003/2004 the legislation was reviewed and the German parliament adopted some amendments to the EEG, which entered into force on 1 August 2004. The aims of these amendments included: to review the amounts reimbursed for renewable energies; to increase the share of renewables in total electricity supply to at least 12.5% by 2010 and to 20% by 2020; to improve the framework conditions for feeding electricity from renewables into the grid and for transmitting and distributing this electricity. Table 4 shows the new reimbursement rates for the various types of technologies:

Besides the EEG (feed-in tariffs), the renewable energy policy has been associated to other policy instruments (investment support, soft loans and tax allowances) in public programs (federal and state level) that offer financial incentives and support programs for introducing renewable technologies in the market. One of the most important programs of the German government was "100,000 Roofs Photovoltaic Program" launched in 1999 to promote the installation of 100,000 photovoltaic installations with a average capacity of 3 kW allowing for an increase of installed photovoltaic capacity by 350 MW. This program was successfully completed in 2003.

2.3.3. Results

The results achieved by Germany are quite impressive. In 1990 the share of renewable energy sources in electricity consumption was just below 4%, in 2003 it reached about 8% and in 2004 it already corresponded to 9.3% (as seen in Table 5). In electricity generation, windpower (44.8%), hydropower (37.6%) and biomass (16.8%) account for the lion's share. In 2004, electricity generation from windpower overtook hydropower. Germany is home to approximately one-third of the worldwide wind installed capacity (16,629 MW). However, there are signs of a downward trend in the installation of new onshore wind farms. This trend is partly due to the limited number of favorable sites available and partly attributable to the higher degression of fees in the amendment to the EEG in 2004 of 2% [21].

According to DIW—*Deutsches Institut für Wirtschaftsforschung* [22], the renewable energy industry is responsible for creating about 110,000 jobs. If we factor in the services sector, this number rises to approximately 120,000 (2002 data).

2.3.4. Barriers

The major barrier found in the policy to promote renewable energies in Germany was the resistance of electricity companies in paying the prices established for the renewable energy generators.

Table 4
Payment rates according to the EEG for new installations that are put into operation as of 01/08/2004

	Annual degression	2004 (€-Ct/kWh)	2006 (€-Ct/kWh)	2010 (€-Ct/kWh)	2013 (€-Ct/kWh)	Duration (years)
Hydro <500 kW	0%	9.67	9.67	9.67	9.67	30
Hydro <5 MW	0%	6.65	6.65	6.65	6.65	
Hydro <150 MW only with modernization—and only payment rate for capacity increase	1%	7.67—an increase in capacity of 500 KW 6.65—an increase in capacity of 10 MW 6.10—an increase in capacity of 20 MW 5.56—an increase in capacity of 50 MW After 2004 annual degression of 1%				15
Landfill gas, sewage gas, pit gas <500 kW	1.5%	7.67	7.44	7.00	6.70	20
Landfill gas, sewage gas, pit gas <5 MW		6.65	6.45	6.07	5.80	
Biomass <150 KW	1.5%	11.50	11.16	10.51	10.04	20
Biomass <500 kW		9.90	9.60	9.04	8.64	
Biomass <5 MW		8.90	8.64	8.13	7.77	
Biomass <20 MW		8.40	8.15	7.67	7.33	
Geothermal <5 MW	1% from 2010	15.00	15.00	14.85	14.40	20
Geothermal <10 MW		14.00	14.00	13.86	13.44	
Geothermal <20 MW		8.95	8.95	8.86	8.59	
Geothermal >20 MW		7.16	7.16	7.09	6.88	
Wind onshore	2%	8.70[a]/5.50[b]	8.36/5.28	7.71/4.87	7.26/4.58	20
Wind offshore[c]	2% from 2008	9.10/6.19	9.10/ 6.19	8.57/5.83	5.49 /5.49	20
Photovoltaic[d]	5%	45.70	40.60	31.02	25.36	20

Source: BMU, 2005 [38].

[a]Increased payment rate—granted from 5 to 20 years depending on the reference yield of the plant; after beginning of basic payment rate.

[b]Basic payment rate.

[c]The increased payment rate is paid with commissioning before 2011; it will be granted for 12 or 20 years depending on the location.

[d]It is also guaranteed for photovoltaic installations on roofs up to 30 kW, a fee of 57.4 € Ct/kWh; 54.6 € Ct/kWh for installation over 30 kW; and 54 € ct/kWh for a capacity of 100 kW and over. For facades, there will be a further payment of 5 cent. These values are applied for 2004. Afterwards a degression rate of 5% will be considered.

Since 1995, when the number of renewable energy projects almost doubled in comparison to the previous year, the electricity companies,[15] represented by the German Electricity Association, questioned the constitutionality of the Law [23]. They argued that the reimbursement paid to renewable energy generators would be an extra tax, which, under the German constitutional Law, would only be legal under certain circumstances. Given this argument, the Association recommended its members (most of the companies in Germany) that they should continue to pay the reimbursement rates defined in the Law

[15]The local and regional energy companies in Northwestern Germany (who have a greater potential for wind energy) became burdened with the reimbursement costs. Resistance increased and led to the first reform of the Law in 1998.

only until its unconstitutionality was not declared. But, in fact, a few companies refused to pay the legal reimbursement and instead, only reimbursed rates for the cost avoided. This generated a response from the states' Cartel Offices. At the same time, the renewable energy generators appealed to the Federal Cartel Office. The adopted legal proceedings were enough for the electricity companies to go back to paying the amount defined by law [3].

From 1995 to 2000, electricity companies also questioned this Law in court. The German Federal Court, however, resisted and did not deny the constitutionality of the Law. In March 2001, the European Court of Justice in Luxembourg ruled that the German provisions for feeding power from renewable energy sources into the grid "do not constitute State aid" and also do not interfere with EU regulations on the free movement of goods (March, 2001). This decision was welcomed by the German government, as the rule put an end to legal insecurity concerning feed-in tariffs and, therefore, also concerning the new EEG [3,20].

More recently (December, 2005), the EC [2] mentioned that Feed-in regulations are the most effective and cheapest way to promote an increased generation of electricity from renewable energy sources.

3. Brazil

3.1. Political context

Brazil has a centralized system of government, concerning energy power production and use. States and Municipalities do not have autonomy to legislate in energy power policies and their potential for action in this area is limited to a few projects, usually in partnership with energy concessionaires and with the financial support of multilateral bodies.

In regulatory terms, the energy industry has been undergoing a series of changes in the past few years. In 1995, the energy market was liberalized[16] and the power industry was privatized and divided in four segments: generation, transmission, distribution and retail. This was the way sought to ensure the investments required to expand energy supply which had been hampered since the 1980s.

With market liberalization, new structures emerged in the domestic scenario: a new regulatory and enforcement agency, ANEEL[17]—National Electric Energy Agency—responsible for promoting and regulating competition in the electricity sector; the Wholesale Energy Market (MAE) to supervise the buying and selling of electricity; and the National Electric System Operator—ONS—to coordinate and control the generation plant and basic transmission network of the interconnected system.

To attract private sector investments, priority was given to establishing natural gas thermopower plants. Nevertheless, Brazil is highly dependent on natural gas imports, and when currency was devalued in 2002, the associated risk made the construction of new thermopower plants impractical. At the same time, the government owned power

[16]Before 1995, the Brazilian power industry was nationalized with strong investments from the public sector.

[17]Key ANEEL tasks: hold tenders for generation; provide concessions and authorizations for new power plants; supervise concession agreements; regulate tariffs; and establish terms of access to the transmission and distribution system.

companies, because of the fiscal equilibrium agreement with the IMF (International Monetary Fund), could not invest in expanding the industry although they had the available resources. Since there was no private investment emerged and demand continued to grow, the risk of an energy deficit rose.

Besides that, the low rainfall in 2001 caused a power shortage, generating a crisis in electricity supply. In response, the government created the Emergency Power Program to increase the national supply of electric power through the use of thermal power plants that were to remain on-call, acting as back-up generation for the electric power system; it also created the PROEOLICA emergency wind power program, which never left the drawing board because of the existing regulatory and financial risks.

In addition, the government adopted a rationing plan to reduce consumption substantially —20% mandatory reduction in consumption. Overall, the program was effective and succeeded in avoiding the power outages. In 2002, when the reservoir levels came back to normal, consumption growth resumed from lower levels than before the energy crisis. This reduced the capacity for investment of the (private) electricity distribution companies.

In 2003, with the election of a new government, it was announced that the power sector reform would be substantially modified and a negotiation process with the major stakeholders was initiated. Thus "the reform of the reform" came into force through Law 10,848/04 approved by the Congress in March 2004.

This "New Power Sector Regulations" replaced the wholesale energy market by a pool of consumer power distribution concessionaires, who are forced to purchase new generation capacity in order to meet the forecasted market growth in the next five years. There will be public biddings to add new capacity to the electric system and the market will be regulated through contracts managed by the Electric Power Trade Board—CCEE (the pool). In the Pool, the existing cheaper energy power will be negotiated with the new one, more expensive, reducing the tariff for the consumer. With the new rules, the government intends to ensure lower tariffs for the consumers, supply security and investments for system expansion. This new arrangement intends to reduce competition and extend the role of regulation. The Energy Research Enterprise was also created, to carry out studies for industry planning.

According to the new model, the central instrument for ensuring lower tariffs is based in tendering procedures where the highest purchase price by the distributors is capped by the CCEE. Then, the generators offer a bid within the capped price and the cheapest one is awarded with a long-term PPA. The cost of acquisition is transferred to the end consumers tariff.

The guiding principles of the New Power Sector Regulations are:

- to recognize hydropower as the major source for expanding electricity services and integrated management of the water stocks;
- to pursue diversification taking into account the complementary nature of other sources; and
- to ensure the supply of electricity to all citizens, connecting all household to the grid or providing decentralized power sources to meet their energy requirements.

Law No. 10,848/04 states that in the public biddings to supply the power companies belonging to the national interconnected system, both energy from existing generating

enterprises (old energy-cheaper) and energy from new generating enterprises (new energy—more expensive), as well as new renewable energy sources will be taken into account. All new generation projects must have environmental permits issued before the public bidding, in order to reduce the risk of new power plants not being commissioned due to environmental problems.

In 2005, public biddings for old energy (hydropower) was held and the negotiated prices (weight average) were around €30/MWh. For new energy, the prices were around €43/MWh for hydropower and around €49/MWh for thermopower.

The new power industry model was approved under a scenario of harsh criticism and divergence of the various actors. According to ABRACE [24] the role of independent power generators under this new regulation remains unclear. And according to Seroa [25], the laws of the new model are not enough to attract private investments and "everything will depend on the mechanisms adopted by the government during the regulation process".

3.2. Renewable energies and adopted policy instruments

Due to its abundant hydrological resources and decades of focus on the development of its energy infrastructure, Brazil has one of the world's largest hydropower installed capacities. In 2005, according to the Ministry of Mines and Energy (MME), the power sector has an installed capacity of around 100 GW, about 70% of which is hydropower. Brazil's remaining power generation capacity comes from coal and an ever-increasing amount of natural gas. Brazil's small northern and larger southern electrical grids were joined in January 1999 into a single grid that services 98% of the country. Brazil's domestic supply is augmented by imports from neighboring Argentina. The main characteristics of Brazilian electricity sector are summarized in Table 6. New renewable energy sources have only a small share in the energy supply mix as shown below.

Historically, the use of RES-E in Brazil was associated to rural electrification programs in isolated communities, where the long distances made extending the electricity grid unfeasible. For example, we had PRODEEM (Program for Energy Development in State and Municipalities). This program was based on photovoltaic systems, and around 5.8 MWp were installed, mainly in schools, health facilities and other community installations.[18] There were also some wind energy initiatives, specially in the northeastern states, which intended to show the technical feasibility of this energy source in the interconnected system. These projects have played the role of demonstration projects, creating awareness and knowledge in expanding the use of RES-E. Regarding biomass from sugarcane bagasse, it was made feasible by the implementation of the alcohol program.

The small share of RES-E can be related to the high generating cost of these sources when compared to hydropower and thermopower. Furthermore, promoting RES-E still has to face the challenge of the country's huge hydropower potential (only 24% of the Brazilian hydropower potential is currently being utilized—but most of the untapped potential is located in the Amazon region). However, no studies are available to assess the share of the hydropower potential that is really feasible, bearing in mind possible environmental impacts and the distance from generation to consumption markets.

[18]The program has faced several difficulties, in particular with regard to long-term operation and maintenance structures. Since 2002 Prodeem is in its evaluation stage, with a view to its restructuring and revitalization.

Table 5
Electricity generation in Germany and employment

Source//year	Electricity generation (GWh)			Employment[a]
	2000	2003	2004	2002
Wind	9500	18,919	25,000	54,000
Biomass	4129	7982	9367	40,000
Solar PV	64	333	459	7000
Hydro	24,936	20,350	21,000	8000
Geothermal (started at November 2003)	0	0	0.4	—
Total	38,629	47,584	55,826 (38,511 GWh from EEG)	110,000
% Gross electricity consumption	6.7	8.0	9.3	

[a]*Source*: DIW—Deutsches Institut für Wirtschaftsforshung, 2005 [22].

Table 6
Installed power capacity

	MW	%
Hydropower[a]	70,140	70
Gas	10,085	10
Oil	5251	5.3
Coal	1415	1.4
Nuclear	2007	2.1
Biomass	3068[b]	3
Wind	28.6	—
Solar	15MWp	—
Imported	8170	8.2
Total	100,165	100%

Source: MME, 2005 [27].
*In 2004, total power generation was around 387,451 GWh, where around 320,797 GWh came from hydropower (82%).
[a]Including 1740 MW of SHP.
[b]71% Sugarcane bagasse.

The more important regulatory framework for RES-E was the approval of Law No. 10.438/2002 (altered by Law 10,762/2003) establishing PROINFA (Program to Encourage Alternative Energy Sources), and determining obligations for electricity concessionaires with respect to the electricity access.[19]

[19]The definition of timeframes for universalization of the energy services will contribute significantly to increasing the use of solar energy and other renewables in areas far from transmission lines. Nevertheless, the choice, of using RES-E or not, is put on the energy concessionaire (based on cost decisions) and there is no additional incentive to pay for the implementation of RES-E to meet these targets.

Table 7
Payment rates—PROINFA 1

Renewable energy source	Premium price—€/MWh (March 2004) 1€ = R$ 2.60	Value corrected by IGP-M index (inflation index) €/MWh (July 2005) 1€ = R$ 2.60
Small hydropower	45.01	50.68
Wind energy	69.30–78.60	78.03–88.50
Biomass	—	—
Bagasse	36.07	40.61
Wood waste	39.69	44.70
Husk rice	38.98	43.90
Biogas	65.03	73.27

Source: Annex II, Act no. 45, 30 of March 2004, Ministry of Mines and Energy (MME).

3.2.1. Program to encourage alternative energy sources—PROINFA

The PROINFA aims to increase the share of wind power, biomass energy and small hydropower (SHP) in the supply of the Brazilian grid system. The first phase of PROINFA[20] intends to add 3300 MW (equally divided among wind power, biomass energy and SHP) to the interconnected system by 2006. The contracts to be signed between Eletrobrás and Independent Power Producers ensure the purchase of energy for 20 years. The main features of PROINFA's first phase (PROINFA 1), according to the Law, are summarized as follows:

- The additional cost of this energy will be equally shared by all households connected to the grid, excluding Low Income Consumers (up to 80 kWh/month, plus a second group under special conditions to be defined by ANEEL–up to 220 kWh/month).
- The Law defines an Independent Power Producer as a company that is not controlled by any other company involved in generation, transmission or distribution of power.
- Equipment manufacturers may participate as Independent Power Producers. However, a minimum of 60% of the equipment value must be manufactured in Brazil.
- ANEEL will regulate tariff reductions of at least 50% for access to transmission and distribution systems for plants generating electricity from wind, biomass and qualified co-generation.[21]

The price of the energy purchased will be the specific economic value (premium price) assigned to each source, as shown above (Table 7).

PROINFA was regulated in March 2004 and the public call for bids attracted projects that sum up to 6601 MW (3681 MW Wind; 1924 MW SHP; and 995 MW biomass).

[20]PROINFA's first phase emphasizes payment of a specific premium price (which varies for each type of renewable energy technology) for renewables to be fed into the grid. The amount (3300 MW) was defined by the federal government and contracts were signed between Eletrobrás (National Energy Holding Company) and the Independent Power Producers.

[21]For SHPs, there was already a regulation that specified this discount.

The projects were chosen by the date of the environmental license. By early 2005, the tender procedures was finished and the 3300 MW were completed (1191 MW SHP; 685 MW Biomass; and 1423 MW Wind).[22]

PROINFA's second phase (PROIFA 2) was projected to ensure that after 20 years, wind energy, biomass and SHP would supply 10% of the Brazilian annual electricity consumption. Call for bids would be made in order to guarantee that a minimum of 15% of the annual electricity market growth would be supplied from these three sources.

As PROINFA was an initiative of the previous government, the New Power Sector Regulations introduced by the new administration elected in 2003, changed PROINFA 2. A possibility currently being considered is that RES-E (biomass, wind and SHP) could enter in the electricity pool (through tendering procedures where the cheapest bidders is awarded with the contract) and their additional cost (over the price of conventional energy) be diluted through the average energy price in such a way that the average price of energy for end consumers should increase up to a cap of 0.5%.

3.2.1.1. Results. PROINFA contracted 144 RES-E projects. However, up to now, only two wind energy projects (a total of 200 MW) and about 300 MW from SHP are under construction. This may be because of the initial delays in the bidding process and shows that the entrepreneurs are having difficulties in meeting the requirements established to get access to funding sources.

If PROINFA 1 is completed successful, a total generation of 11,334 GWh/year will be achieved, (taking into account the capacity factor of 50% for SHP, 50% for biomass, and 25% for wind energy. This amount represents almost 3% of the total country's electricity generation.

3.2.1.2. Barriers. The PROINFA 1 is similar to the model adopted in Germany with a cap of 3300 MW, i.e. the amount of RES-E is limited by the government and a premium price is offered for the renewable energy generated. It is not an obligation on distribution companies or on consumption. It was adopted in a favorable political period when policymakers were aware of the benefits of this sources and encouraged by some pilot-projects. Also, the international scenario of supporting clean energy and the concerns related to the Kyoto protocol played a relevant role in the design and approval of PROINFA.

Nevertheless, there is still a pending question about the Brazilian case: how strongly do the government and policymakers really want to promote RES-E? With the adoption of the New Power Sector Regulations and the tendency of RES-E entering into the Pool and participating in the tendering procedures, only the most competitive sources will be able to take a share of this market. Mainly wind energy will suffer a major negative impact and will have problems to ensure its economic feasibility.

The PROINFA 1 faces some obstacles, putting at risk the commissioning of the contracted projects, particularly of wind energy plants. The definition of PROINFA 2 is

[22]The biomass sector did not respond as expected. Some projects were taken back by the entrepreneurs because they found the energy purchase price for biomass very low The government believes that the sugar–alcohol industry is likely to get high returns in the sugar and alcohol markets and investing in long-term power generation does not attract great interest. Therefore, the contracted capacity of SHP and wind energy were expanded to meet the original 3300 MW target.

also essential to attract new investments and new wind energy manufacturers and facilitate investments for PROINFA 1.

The main barriers include [25,27]:

- The selection criteria established in the PROINFA 1 did not take in consideration the generation cost and the efficiency of the projects. Indeed, the projects were selected based on the date of the environmental license.
- The definition given by law to Independent Power Producers restricts the access of large energy power companies that could provide significant investments in the RES-E projects. It has led to some difficulties in raising the initial required financial resources.
- The price negotiated in the public bidding for thermopower was around 49€/MWh, a figure higher than the premium price established in PROINFA for bagasse-fired power plants.
- Small number of wind energy manufacturers in Brazil and difficulty of the national industry, in general, to produce the required equipment to achieve the construction of 3300 MW capacity in a short period.
- Furthermore, in Brazil, each state has their own environmental legislation and those projects that were located in states that have a more restrictive legislation took longer to get the environmental license.

4. Conclusions and recommendations

Some instruments (associated to an effective policy) have been shown to be more efficient than others. For instance, the feed-in tariffs in Germany have proved by far to be the most efficient system compared to many other implemented support models in Europe. The quota obligation with green certificates proves to be interesting, but it is still a too young instrument for evaluating its effectiveness and still faces problems regarding long-term investments. This instrument could be very valuable for developing countries if green certificates could be negotiated in international markets. It would allow for an increase of the renewable energy industry activity on a global level. The voluntary model does not present good prospects in Brazil. Likewise, an instrument similar to an ecotax would not address the Brazilian situation, as the main concern of the government is to reduce energy tariffs.

The promotion of RES-E in Brazil still faces large difficulties mainly due to cost factors. Since, in Brazil, the price of energy for the end consumer is of particular significance, the challenges to expand the share of RES-E in its energy supply mix are mostly related to cost reduction. The support to this goal through a long-term policy is still unclear today: PROINFA 1 requires adjustments such as revision of selection criteria for wind energy projects and greater access to financing and credit. PROINFA 2 must be redefined under the New Power Sector Regulations. The lessons from the European experiences need to be taken into account:

- The results achieved in UK with tendering procedures were not significant. The instrument generated a high degree of price competition which did not reflect the real generation cost, and thus, failing in commissioning new capacity.

- Complex instruments and frequent phase- in and -out of the adopted policies are not desirable, as seen in the Netherlands. The policy should be clear and consistent, and its continuity ensured in the long term.
- The policy should allow the support of all renewable technologies bands and not just the most competitive as observed in the UK under Renewable Obligation.
- The level of the premium price paid under feed-in tariffs should be adequate to support non-competitive technologies as wind energy. As example, the level of support in Holland under feed-in schemes favored mostly biomass technologies.
- The feed-in systems is by far the most successful instrument. It has enough flexibility to follow technological changes and allows tariffs to be adjusted as the technology develops. Furthermore, this instrument allow a greater scale introduction of RES-E.
- Quota System is better applied for mature markets. The Renewable Obligation has a higher level of support and under this scheme the renewable energy generators are facing some difficulties for obtain long-term contracts.

At any rate, it is important to stress that, more than the nature of the instrument itself, the success of promoting renewable energies depends mostly on the political support as well as on the interest of the stakeholders involved in the process and the capacity of their participation at the local and regional levels.

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